

## Radiation-Hard Ka-Band Power Amplifier for CubeSats, Phase I

Completed Technology Project (2015 - 2015)



## Project Introduction

The objective of the proposed work is to design and simulate a radiation hard fully-integrated gallium nitride (GaN) based Ka-band power amplifier (PA) for Cubesats. As detailed in NASA's Phase I solicitation subtopic "S1.02 Microwave Technologies for Remote Sensing", the needed power amplifier should exhibit greater than 32W of saturated output power ( $P_{sat}$ ) with a power-added efficiency (PAE) over 20%. The amplifier should maintain over 35dB gain within the frequency range of 35.5 GHz to 35.9GHz, and be implemented in a single-package solution with small form factor of less than 1cm<sup>3</sup>. To enable versatility and scalability to future scientific space applications, as well as radar and satellite communications applications that may operate in slightly modified frequency bands, the proposed amplifier will be designed to exceed the NASA requirements detailed above. The proposed amplifier will be designed in the TriQuint 0.15um gallium nitride on silicon carbide (GaN-on-SiC) fabrication process and have an extended frequency range from 34GHz to 38GHz, extended operating temperature range from -55°C to 125°C, sufficient linearity to transmit QPSK modulation schemes, and single MMIC maximum output power ( $P_{sat}$ ) of 16W. In order to achieve an output power beyond 32W, 3 MMICs shall be integrated within a single package (multi-chip module) with power splitting and combining integrated in the module's substrate. Furthermore, this work shall explore the feasibility of operating the GaN PA at temperature extremes, ranging from -240C to +250C, as requested by some of NASA's lunar and planetary missions.

## Primary U.S. Work Locations and Key Partners

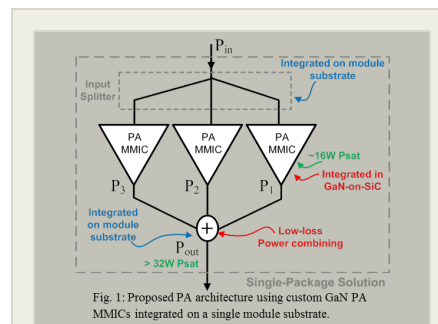
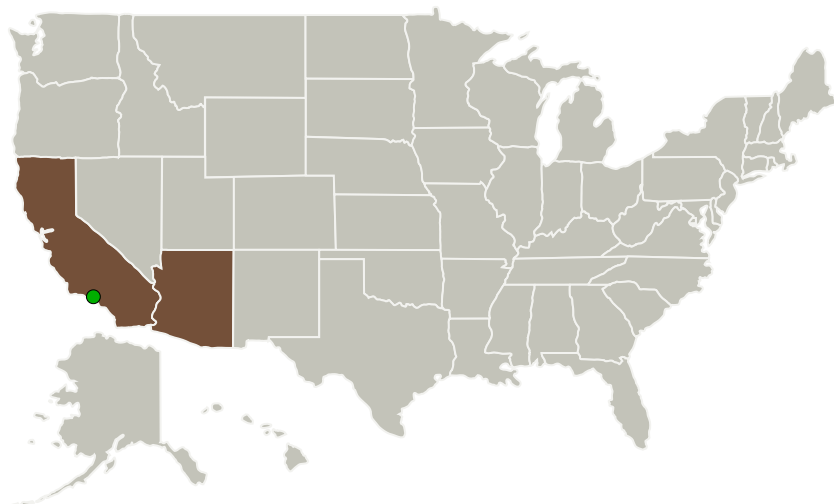


Fig. 1: Proposed PA architecture using custom GaN PA MMICs integrated on a single module substrate.

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## Radiation-Hard Ka-Band Power Amplifier for CubeSats, Phase I



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Organizations Performing Work	Role	Type	Location
Alphacore, Inc.	Lead Organization	Industry	Tempe, Arizona
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

## Primary U.S. Work Locations

Arizona	California
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## Project Transitions

▶ **June 2015:** Project Start

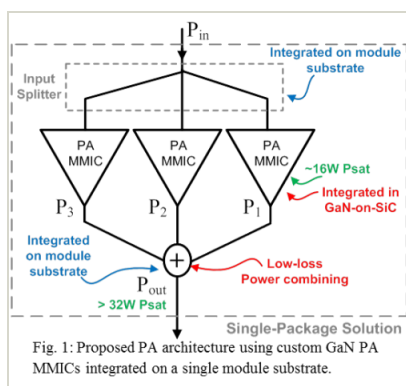
✓ **December 2015:** Closed out

**Closeout Summary:** Radiation-Hard Ka-Band Power Amplifier for CubeSats, Phase I Project Image

**Closeout Documentation:**

- Final Summary Chart Image(<https://techport.nasa.gov/file/139375>)

## Images

**Briefing Chart Image**

Radiation-Hard Ka-Band Power Amplifier for CubeSats, Phase I  
(<https://techport.nasa.gov/image/137253>)

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Alphacore, Inc.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

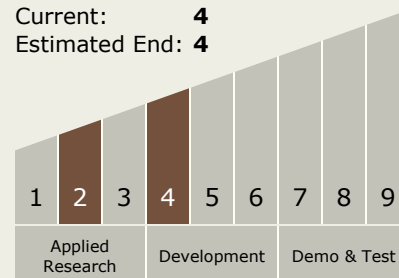
Carlos Torrez

**Principal Investigator:**

Esko Mikkola

## Technology Maturity (TRL)

Start: 2  
Current: 4  
Estimated End: 4



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## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System